JOURNAL OF RESEARCH IN PERSONALITY 24, 323–337 (1990)

Electroencephalographic Validation of a Temporal Lobe Signs Inventory in a Normal Population

KATHERINE MAKAREC

York University, Downsview, Ontario

AND

MICHAEL A. PERSINGER

Laurentian University, Sudbury, Ontario

In two separate experiments 61 18- to 35-year-old part-time university students were given the Personal Philosophy Inventory (PPI) that contained items that infer temporal lobe lability. Alpha activity seconds per minute during a 10-min recording (equal intervals of eyes opened or eyes closed) were obtained from the temporal and occipital lobes for each subject. Positive, intermediate strength correlations were obtained between the total numbers of different temporal lobe signs as measured by the questionnaire and both the average amount (eyes closed) of the variability in α activity from the temporal but not the occipital lobes. The results support the construct validity of the temporal lobe signs inventory and suggest that a continuum of temporal lobe lability (as inferred from both experimential and electroencephalographic criteria) exists within the normal population. © 1990 Academic Press, Inc.

Patients with electrically active foci within their temporal lobes frequently display a predictable cluster of experiences (Bear & Fedio, 1977; Geschwind, 1983) that are also evoked by surgical stimulation (Gloor, Oliver, Quensey, Andermann, & Horowitz, 1982; Goldensohn, 1983; Horowitz & Adams, 1970). These experiences include deja vu, formed visual hallucinations, the sense of a presence, mystical (paranormal) experiences, unusual smells, anomalous voices or sounds, vestibular movements, and anxiety. Over time these patients may display a greater predilection for circumstantial thinking, perseverative ("viscous") or

Correspondence and reprint requests should be addressed to Dr. M. A. Persinger, Behavioral Neuroscience Laboratory, Dept. of Psychology, Laurentian University, Sudbury, Ontario, Canada P3E 2C6.

0092-6566/90 $3.00
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stereotyped thinking, a sense of personal destiny or uniqueness, elaborate delusions, and excessive interests in religious or philosophical topics. Usually there is a deepening and widening affect within the person's cognitive life such that metaphorical language (poetry), unusual events, or infrequent occurrences become very meaningful or implicative of cosmic forces.

We (Makarec & Persinger, 1985; Persinger, 1983; Persinger, 1987a; Persinger & Makarec, 1987) have suggested that these behaviors are merely extreme manifestations of a continuum of temporal lobe lability that extends throughout the normal population. During the last 10 years, the Personal Philosophy Inventory (PPI) has been developed to test the presence of the weaker analogues of complex partial epileptic symptoms within the normal population. We have reasoned that the more different temporal lobe symptoms a person experiences, the more closely his or her personality and behaviors should approximate (but without either the overt seizures or brain-damaging consequences) the profile of a person with an electrical focus within deep temporal lobe structures (Persinger & Makarec, 1987). For example strong positive correlations have been shown between scores on clusters of items that refer to temporal lobe signs and the numbers of paranormal experiences (Persinger, 1984), a sense of a presence, and the propensity to write prose or poetry (Persinger & Makarec, 1987).

Normal people who report frequent and varied temporal lobe signs are also more suspicious, aloof, stereotyped in behavior, ruminative, judgmental, and submissive before authority according to the California Psychological Inventory compared to people who report fewer signs (Persinger & Makarec, 1987). There are strong correlations between temporal lobe signs and the *F* (an inference of unusual response patterns), hypomania, and schizophrenia scales of the Minnesota Multiphasic Personality Inventory (Persinger, 1987b). The former (*F*) correlation has been explained as an example of the increased widening of affect and is commensurate with Bear's (1979) hypothesis of "sensory–limbic hyperconnectionism." The last two correlations are considered consistent with the long suggested role of the temporal lobes (particularly deep structures) in both bipolar affective and thought disorders (Tryer & MacKay, 1986). Factor analysis of the items within the clusters of deep temporal signs have been consistent across several samples of the normal population (Persinger & Makarec, 1987). Unpublished clinical data (Persinger, 1989) with a small number (18) of newly diagnosed patients (maintained primarily on Tegretol) with verified epileptic foci within either temporal lobe (but with no or mild brain impairment according to a neuropsychological test battery) indicated that their responses saturated the scale.

To further determine the construct validity of the PPI as an indicator of temporal lobe activity, we designed the following experiment. Our hypothesis was simply that a moderate positive correlation should exist between the variability of α activity over the temporal lobes and scores on items that refer to experiences that are similar to those evoked by intrinsic stimulation. The concept of lability was derived from our clinical observations that normal people who display more bipolar temporal lobe α activity also undergo more frequent variations between this frequency range and higher frequencies. Considering the predominant modulation of temporal cortical activity by the amygdala and the hippocampus (Girgis, 1986) we inferred that normal elevations of the intrinsic electrical lability in these structures should be reflected as frequent variations in the occurrence of temporal lobe α activity. Stevens (1982) has concluded that periods of lower frequency activity within the temporal lobe reflect a shift to and an increase in the activity of the hippocampus and the amygdala.

METHOD

Subjects

Sample 1. During the summer of 1984, 29 subjects (15 males and 14 females) in a third year psychology class at Laurentian University served as subjects. Their ages ranged from 18 to 30 years (median = 24).

Sample 2. During the summer of 1985, 32 students (20 female and 12 males) in an introductory psychology class at Laurentian University served as subjects. Their ages ranged from 20 to 35 years (median = 23). All subjects denied a history of epilepsy.

Procedure

The procedure was similar to that described by Makarec and Persinger (1985). Each subject was asked to sit in a comfortable chair within a quiet room. The subject was told that the purpose of the experiment was to determine the effects of relaxation music upon brain activity. E45 silver-plated disc electrodes were attached by EC2 electrode cream to the scalp within the same plane at the level of the occipital (01/02) and temporal (T3/T4) lobes. After approximately 3–5 min of habituation and instructions concerning the importance of remaining immobile to reduce motor artifacts, bipolar measurements were recorded by a Grass Model 79 electroencephalograph.

Baseline measures were taken during the first 5 min when the subject was asked to keep the eyes opened or closed for 1 min each; eyes-open (EO) conditions were always followed by eyes-closed (EC) conditions. The next 4 min involved the presentation of sound stimuli. They were given for 10 sec at the beginning of each minute before instructions were given to close or to open the eyes. The sounds were segments from an Astral Sounds Tape (San Francisco, CA); it contained exotic tones and beats that ranged between 7 and 10 perceptible pulses per second. This temporal pattern was selected because of (a) its potential resonance with the intrinsic electrical periodicity of amygdaloid neurons, (b) the (auditory) modality specificity of the the temporal lobes, and (c) the potential for "entrainment" within the θ to α range. The sounds were presented 1.5 m behind the subject at a sound level of 71 dB. A final 1-min interval (no sounds, eyes closed) completed the recording interval. An

assistant, who sat about 4 m in front of the subject, verified compliance with the instructions.

Every second of each subject's record for the 10 min of measurement was evaluated. Each second of the record for each output (temporal and occipital) was given either a 0 or a 1 for the presence of α frequency for more than 0.5 sec. The numbers of α seconds per minute were calculated separately for the eyes-open and the eyes-closed condition for the baseline and sound periods.

Instrument

The PPI was administered during class time approximately in the center of the 3-week interval that involved the EEG measures for each sample. This inventory is composed of 140 items to which the subject responds true or false. It contains information items (e.g., history of seizure), items to control for silly responders (e.g., "I have been taken aboard a spaceship"), portions of the MMPI L scale, references to frank paranormal experiences (e.g., telepathy, precognition, without the use of the words specifically), and items intended to assess religious dogmatism (e.g., "If God told me to kill, I would do it in his Name") or exotic interests ("I would like to time travel").

Three groups of items were extracted (Makarec & Persinger, 1985; Persinger, 1984); they include the general temporal lobe signs (TLS) cluster (n = 30 items), the complex partial epilepsy (ictal) signs (CPES) cluster (n = 16 items), and the control cluster (n = 16 items). The latter is composed of items that refer to normal proprioceptive and phenomenological experiences and serves as a control for "yes" responders. The control items have been published elsewhere (Persinger & Makarec, 1987), while the items for the TLS and CPES clusters are shown in Table 1. The score for each cluster was simply the number of yes responses divided by the number of total items (multiplied by 100). To eliminate the possibility of bias, PPI profiles were scored (by computer) after the EEG records had been analyzed.

The 10-day test–rest reliability of the two clusters that infer temporal lobe signs and the control cluster is about 0.90; the 100-day test–retest coefficients are about 0.70 (Persinger, 1984). Typical mean item-cluster average correlation coefficients for TLS clusters are about 0.40 to 0.50 but about 0.25 to 0.30 for the control cluster; reliability (α) coefficients are typically around 0.70 for the TLS clusters and about 0.30 for the control cluster. The moderate to strong magnitude coefficients for the temporal lobe clusters suggest that most (i.e., 15 of 16 items in the CPES and 25 of 30 in the TLS) items contribute to the cluster's score; this relation has been inferred to reflect a general "temporal lobe factor." The smaller magnitude coefficients and the less frequent contribution of control items (e.g., 8 of 16) to that cluster score are expected because they are intended to assess simple "yes" responding to descriptors of internal states rather than to indicate a strong, shared source of variance. Both TLS and CPES clusters have been shown to display both discriminative and convergent validity (Makarec and Persinger, 1985). Although they exhibit similar, moderate magnitude correlations with other scales (such as the MMPI and CPI), the two clusters were designed to serve two separate functions: a wide net of items that include all facets of limbic-related behaviors and a narrower net of items that is specific to ictal (brief electrical) displays.

Analysis

Several types of analysis were conducted. The first involved bivariate Pearson product–moment correlations between the scores for the temporal lobe or control clusters and the numbers of α seconds per minute from (a) the occipital lobes and (b) the temporal lobes. The second analysis involved calculation of the variability in α activity above the temporal

TABLE 1

ITEMS THAT COMPOSED THE MAJOR CLUSTER (TLS) AND MINOR CLUSTER (CPES) OF THE TEMPORAL LOBE SCALE OF THE PERSONAL PHILOSOPHY INVENTORY

1. While sitting quietly, I have had uplifting sensations as if I were driving over a rolling road. (CPES)*
2. I keep a diary or notebook about my feelings and thoughts.*
3. When I lose an argument, I spend a lot of time thinking about what I should have said.*
4. I have been known to walk in my sleep.*
5. I often feel as if things are not real. (CPES)*
6. At least once in my life just, before falling down, I had the intense smell from childhood. (CPES)*
7. Once in a crowded area I suddenly could not recognize where I was. (CPES)**
8. I have had a vision. (CPES)**
9. About once a year, I will awaken and not be able to move.*
10. As a child I played with an imaginary friend.*
11. At least once in the last 10 years I have fallen asleep and then awakened the next morning in another room.
12. People tell me I "blank out" sometimes when we are talking.
13. Intense smells bother me more than most people.
14. When relaxed or just before falling asleep I sometimes feel pleasant vibrations moving through my whole body. (CPES)
15. Sometimes in the early morning hours between midnight and 4:00 AM, my experiences are very meaningful. (CPES)
16. I have heard an inner voice call my name. (CPES)
17. After writing poetry or prose, I feel better.
18. When I get upset or angry, my legs feel weak.
19. When I walk upstairs, I sometimes note a strange smell from nowhere. (CPES)
20. I use "hunches" more than simple learning to solve new problems. (CPES)
21. At least once a month, I experience smells that do not have an obvious source. (CPES)
22. Once I start talking in an enjoyable setting, I have a hard time leaving.
23. Sometimes an event will occur that has special significance for me only. (CPES)
24. If I breath quickly, I feel dizzy or odd.
25. I have had experiences when I felt as if I were somewhere else. (CPES)
26. There have been times when I stared at an object and it appeared to become larger and larger. (CPES)
27. Two or three times in my life, there have been a few brief moments when I felt very close to a Universal Consciousness.
28. I have dreams of floating or flying through the air at least once a year. (CPES)
29. When I have a tough decision to make a sign will be given and I will know what to do. (CPES)
30. At least once in my life very late at night, I have felt the presence of another Being.

Note. The order of the items does not reflect their order in the inventory.

and occipital lobes by (a) computing the standard deviation of the mean numbers of α seconds per minute for the 5 min when the eyes were closed for the baseline and for the sound conditions and (b) computing the standard deviation of the numbers of α seconds per minute for the 5 min of baseline measurements only (eyes opened and closed included). These measures were calculated to help determine intrinsic variability (eyes open vs eyes closed) and extrinsic variability (when the eyes were closed) in response to the auditory input.

To assess the independence of the correlations between α activity within the temporal and occipital lobes and the cluster scores, partial correlations were completed between each of the three cluster scores and α activity when the appropriate measure from either lobe was held constant. To determine an "optimal" correlation with the appropriate items, all items ($n = 10$) that demonstrated a statistically significant coefficient ($p < .05$) with temporal lobe α activity (eyes closed) were added into an additional empirical cluster (the ETLS) and then correlated with the various measures of α activity; partial correlations were also performed.

Additional analyses involved determining the separate correlations between the EEG measures and the two cluster scores for baseline and sound presentation periods. The latter analysis was completed in order to test the possibility that sounds (considering the temporal lobe is the primary receptive and interpretive center for this modality) may differentially affect the correslations between temporal lobe scores and α activity. To determine if there were any alterations in the absolute amount of α seconds per minute due to sound exposure, multivariate analyses of variance were completed with two levels repeated (closed eyes vs open eyes; baseline vs sound exposure) and one independent variable (the scores on the TLS cluster were collapsed into four groups according to successive increments of 25th percentiles) for the α seconds per minute in the temporal and occipital lobes, separately. We did not compare the activity of the occipital and temporal lobes directly because of the large and potentially obscuring discrepancy in α time between the two lobes. All analyses were completed by SPSSX software on a VAX system computer.

RESULTS

The numbers of α seconds per minute from the temporal and occipital lobes for the EO and the EC condition were similar for both groups. The means and standard deviations for Group 1 and Group 2, respectively, for each measure were: temporal lobe (EO), 1.0 ($SD = 1.2$), 1.8 ($SD = 4.0$); temporal lobe (EC) 3.5 ($SD = 3.8$), 5.0 ($SD = 6.0$); occipital lobe (EO) 3.1 ($SD = 4.7$), 5.1 ($SD = 7.1$); and occipital lobe (EC) 17.4 ($SD = 13.0$), 19.5 ($SD = 13.2$). The TLS cluster scores for the two groups were 31% ($SD = 16\%$) and 33% ($SD = 14\%$), while the CPES cluster scores were 32% ($SD = 15\%$) and 34% ($SD = 16\%$), respectively; control scores were 78% ($SD = 11\%$) and 76% ($SD = 11\%$). The mean item-cluster average correlations for the TLS, CPES, and control clusters were 0.49, 0.40 and 0.29, respectively; α coefficients were 0.78, 0.83 and 0.26, respectively.

The correlation coefficients between the numbers of α seconds per minute from the occipital and temporal lobes when the eyes were opened or closed and scores on the TLS and control clusters are shown in Table 2 for both groups separately and combined. As can be seen the only

TABLE 2
CORRELATION COEFFICIENTS[a]

	Cluster					
	TLS			Control		
	G1 (n = 29)	G2 (n = 32)	Total (n = 61)	G1 (n = 29)	G2 (n = 32)	Total (n = 61)
	α sec/min					
Temporal						
EO	−0.08	0.38*	0.23	−0.25	−0.20	−0.19
EC	0.48*	0.43*	0.44**	−0.15	−0.08	0.11
Occipital						
EO	0.23	0.35	0.29	−0.42*	−0.01	−0.19
EC	0.37	−0.03	0.10	−0.29	0.05	−0.10

[a] Between the percentage of affirmative responses on the clusters of temporal lobe signs (TLS) and the control items and the numbers of α seconds per minute during eyes-open (EO) and eyes-closed (EC) conditions for temporal lobe and occipital lobe measures.
* $p < .01$.
** $p < .001$.

consistent statistically significant ($p < .01$) correlations (that ranged from 0.43 through 0.48) occurred between scores on the temporal lobe signs cluster and the numbers of α seconds per minute from the temporal lobes when the eyes were closed. This EEG measure was the mean of 5 separate min each of which had been preceded and followed by a 1-min period with the eyes opened. A scattergram that depicts the relationship between the numbers of α seconds per minute from the temporal lobe (eyes closed) and the TLS score is shown in Fig. 1. Correlations between this temporal lobe activity and the TLS scores for the baseline and sound presentation periods were 0.21 and 0.18 when the eyes were open and 0.37 ($p < .01$) and 0.37 ($p < .01$) when the eyes were closed.

Zero order and partial correlation coefficients (with α seconds per minute from the other lobe held constant) between the clusters of items and indices of α activity are shown in Table 3. These items composed the TLS, CPES, ETLS (statistically derived; items indicated by asterisks in Table 1), and control clusters. The EEG measures were (1) the mean α seconds per minute (eyes closed), (2) the standard deviation of α seconds (eyes closed only) between the baseline and the sound condition, and (3) the standard deviation of α seconds during the baseline condition only (eyes open and closed combined) for the temporal and occipital lobes.

As clearly noted the strongest statistically significant correlations oc-

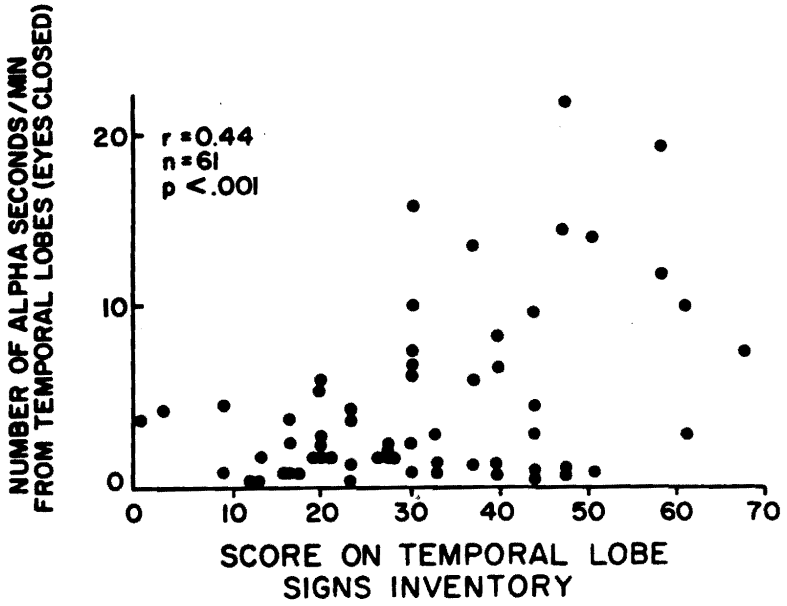

FIG. 1 Mean numbers of α seconds per minute over the temporal lobes (bipolar arrangement, T3/T4) when the subjects' eyes were closed and scores for items that comprise the temporal lobe signs (TLS) cluster from the Personal Philosophy Inventory (PPI).

curred between the average and lability (standard deviation) measures of temporal lobe α activity and the three clusters of items that imply temporal lobe signs. Scores on the control cluster were not correlated significantly with α activity from either lobe. Whereas the strength of the relation between temporal lobe signs and temporal lobe activity was not appreciably reduced when the α measures from the occipital lobes were held constant, the weak marginally significant correlations between these clusters and occipital measures were eliminated when temporal lobe activity was held constant.

Multivariate analysis of variance (MANOVA) with two levels repeated (eyes opened vs eyes closed; baseline vs sound condition) and one level held as independent (four groups of successively increasing TLS scores) for the square root (in order to meet the assumptions of variance homogeneity) of the numbers of α seconds per minute were completed for each lobe separately. The temporal lobe analysis indicated a significant difference between the four groups of subjects who displayed progressively increasing frequency of temporal lobe signs ($F(3, 57) = 3.00$, $p < .05$); this result reflected a linear increase in overall temporal lobe α activity with increasing numbers of temporal lobe signs and reiterated the previous zero order correlations. Not surprisingly a significant ($F(1, 57) = 71.87$, $p < .001$) increase in α occurred during the eyes-closed condition compared to the eyes-opened condition. However there were no statistically significant interactions between the TLS score and α activity as

TABLE 3
ZERO ORDER AND PARTIAL CORRELATION COEFFICIENTS[a]

EEG measure	Constant	TLS	CPES	Control	ETLS
TAC		.44**	.36*	.07	.53**
TAC	OAC	.38**	.30*	.10	.48**
OAC		.24	.20	−.02	.23
OAC	TAC	.01	.01	−.07	.03
SDTB		.40**	.33*	−.12	.48**
SDTB	STOB	.35*	.29*	−.05	.46**
SDOB		.20	.16	−.01	.20
SDOB	SDTB	.06	.05	−.05	.02
SDTC		.39**	.36*	.03	.38**
SDTC	SDOC	.37**	.29*	.07	.28*
SDOC		.25*	.21	−.07	.32**
SDOC	SDTC	.06	.02	−.05	.16

[a] Between the percentage of affirmative responses on the major (TLS), minor (CPES), control, and empirical (ETLS) clusters and the average numbers of α seconds per minute from the temporal (TAC) and occipital (OAC) lobes or the standard deviation of α activity from these lobes during the baseline (SDTB and SDOB) or for the eyes-closed condition only (SDTC and SDOC) during the entire session.

* $p < .01$.

** $p < .001$.

a function of ocular status or baseline-sound presentation, i.e., there was no differential increase in temporal lobe α activity during the sound condition.

The repeated measure analysis for the occipital lobe α activity indicated no difference between TLS groups ($F(3, 57) = 1.20, p > 0.05$). In addition to the expected large increases in α activity when the eyes were closed, there was a significant ($F(1, 57) = 7.92, p < 0.001$) baseline-sound by ocular status interaction. This was due primarily to the relatively reduced α activity during the sound condition vs the baseline when the eyes were closed compared to when they were open. There were no other statistically significant effects.

To ensure the specificity of the temporal lobe α activity effect, we completed a series of stepwise multiple regressions for each of the four clusters of items and the four major α activity measures for eyes open or closed from the occipital or temporal lobes. Only the variable of temporal lobe α during the eyes-closed condition entered the equation for each of the three clusters involving TLS items but not for the control cluster.

Although technically tenuous, we decided to explore the extent of the differential loading of TLS items on temporal lobe α activity (eyes

closed). To determine if the a priori cluster of items that composed the TLS measure was maximally correlated with the EEG measures, 20 of the 30 TLS and 16 of the control items were used as independent variables in a stepwise multiple regression. The items that were not used had *pq* values of less than 0.30 or greater than 0.70 (i.e., less than 30% or more than 70% of the people saying no or yes and hence potentially distorting the analysis). Ten variables from the TLS list (9 of the 10 that were included in the statistically derived cluster, ETLS) and none of the variables from the control cluster entered the equation; the resulting multiple r was 0.54 ($F(10, 50) = 10.61$, $p < .001$). On the other hand, when occipital lobe α activity was used as the dependent variable, only 2 of the 20 TLS variables entered the equation; they are indicated by double asterisks in Table 1.

DISCUSSION

The numbers of experiences that are considered weaker equivalents of those evoked during intrinsic or extrinsic stimulation (*without* afterdischarges) (Gloor et al., 1982) of deep temporal lobe structures are significantly correlated with quantitative measures of α activity above this region. Both the amount of α time and our index of temporal lobe lability (the variability in α time across conditions) were positively associated with these experiences. They are not diffuse or nonspecific reports because (1) the scores on the clusters of temporal lobe signs were not as strongly correlated with α activity from the occipital lobes and (2) responses to the control cluster of items were not significantly correlated with temporal lobe α activity.

The moderate strength of the relationship was expected in light of the limits of psychometric tools and electroencephalographic measurements. Possible methodological artifacts were reduced by the "blind" analysis of the EEG records and computation of TLS scores after the records had been completed. The consistency of the relationship is implied by the similarity of the strength of the correlation between the two studies. Discriminant validity of the items from the TLS clusters was indicated by their specific positive correlations with temporal lobe α activity but not with occipital lobe α activity measures; this was most evident with partial correlational analyses. When the contribution from temporal lobe activity was held constant, the weak correlations between temporal lobe signs and occipital activity were eliminated. However the statistical significance of the temporal lobe activity measures and temporal lobe signs were not diminished appreciably when occipital lobe activity was held constant. These results indicate that although α seconds per minute between the occipital and temporal lobes may be moderately correlated (0.50), this shared variance was not responsible for the correlation be-

tween temporal lobe activity and the scores on the temporal lobe clusters. Additional, although less rigorous, validity (in light of the number of items and subject sample) was indicated by the entrance of only temporal lobe scale items and not any of the control items when conservative criterion was used to predict temporal lobe α activity.

Although the music decreased the relative duration of α activity from the occipital lobes, this "7 to 10 pulses per second" pattern did not enhance the TLS effect systematically. The correlation coefficients between α activity (eyes closed) during the baseline or sound conditions and the TLS clusters were similar. There was also no significant change in the absolute amount of α activity as determined by repeated measures analyses.

However there must have been differential responding to the sound as a function of the TLS score. Both the average temporal lobe activity when the eyes were closed (sound and baseline combined) and the standard deviation of this activity for the sound condition were similarly correlated with TLS clusters. If the effect of the sound had been negligible, then the α activity scores for the one condition should have been similar to that of the other, in which case the standard deviation would have been minimal. Because it was not, the possibility that people who score higher on the TLS clusters show greater enhancement of suppression (i.e., lability) of temporal α activity must still be determined.

The reliability of these items as predictors of temporal lobe α activity and lability is also indicated by the similar magnitude of correlations for clusters of items that were selected on both conceptual (TLS and CPES) and statistical (ETLS) bases; differential effects between these two types of derivations have often plagued other types of inventories regarding temporal lobe function (Stark-Adamec & Adamec, 1986). Although the similarity of the magnitude of the correlation between the TLS (30 items) and the CPES (16 items) suggests that the former may contain redundant items, we still consider this "wide net" vs "restricted net" approach important. Because the CPES cluster contains items that refer to primarily "ictal-like" or microseizure-like displays relative to the TLS cluster that also contain items that imply classic "interictal" signs (that often emerge with insidious structural alterations in the brain), the efficacy of the TLS cluster may only be obvious in populations that display a longer history of CPES symptoms or that have persistent electrical foci within the temporal lobes.

The use of subjective experiences to infer electrical activity within and the functional organization of the temporal lobe is not novel and has been used creatively by many innovative thinkers (Gloor et al., 1982). However the same structures that affect these experiences are also involved with the integration of subjective emotional states with memory

and cognition. If microstructural damage to these areas occurs, then memory could be markedly modified and its validity for sampling and inferencing experiential detail would be questionable. This important factor is the primary caveat to the routine application of our approach to clinical populations.

Indeed, the variability of microstructural damage within these areas is very likely to be the primary source of the controversy regarding the existence of specific personality traits within the temporal lobe epileptic population. It is well known that distinctly different symptoms arise as a result of a structural or an electrical lesion (Girgis, 1986) and temporal lobe epileptic populations are notoriously heterogeneous (Stark-Adamec & Adamec, 1986) because of the almost unlimited extent, progression, and causes of the microstructural anomalies. In light of the newer approaches to the etiology of adult epilepsy, the apparent overlap of experiential symptomatology between populations that display verifiable temporal lobe foci and those that exhibit generalized convulsions (Hermann & Whitman, 1984) may reflect their shared neural triggers within deep limbic structures. A variety of sources can evoke limbic seizures; their visible expression is a function of access to motor pathways (Gale, 1988) and the microarchitectural or subtle chemical differences of the person's brain.

Our results should not be confused with the issue of "epileptic personality." Both protagonists and antagonists of this concept (Stevens, 1988) have (1) relied upon studies that have utilized qualitative ("pathognomic") criteria or (2) ignored a critical variable: the stage of the development of the epileptic process (Rodin, 1987) when the behavioral measurements were taken. Quantitative data suggest the existence of a continuum of temporal lobe lability within the normal population. From this perspective all of the major phenomenological experiences (rather than personality) that are reported by patients who display complex partial epileptic seizures or who have deep temporal lobe structures stimulated by surgical techniques should be reported in a less intense manner and with a lower frequency by normal individuals with no history of epilepsy.

The rationale for this hypothesis is that excessive electrical activity displayed by the temporal lobe patient is an exaggeration of the normal operating principles of the human brain. Microseizure-like activity is a normal function of deep limbic structures during sleep (Stevens, 1982); the hippocampus (the gateway to memory) functions normally by paroxysmal discharges (Taylor, 1988). When they become relatively excessive, the influence spreads and recruits the activity and the experiential correlates of adjacent structures; when they become extreme and uncontrolled, motor convulsions emerge. The rationale is also supported

by the recent work of Goldensohn (1983) who found that EEG-verifiable foci are actually composed of a "critical" density of microfoci. These microfoci appear to be electrically unstable cortical columns that are less dense but nonetheless present in the *normal* brain.

The selection of the items for the TLS cluster of the PPI was based on the continuum hypothesis. Consequently the items were phrased to reflect weaker manifestations of classic temporal lobe epileptic experiences. The analogue of the frequent sensations of "gnawing" or proprioceptive movements from epigastric regions to the throat was stated as items 1 and 14 (Table 1). Modified manifestations of widening of affect were indicated by item 15, while modified experiences of "a sense of the personal" were indicated by item 23. Similarly, low-level dissociated states (which probably range from brief intermittent dreamy states to the formation of fragmented multiple personalities in frank complex partial epilepsy) were indicated by items 5, 11, and 25. The visual and olfactory item-equivalents are more obvious.

Although our measures of temporal lobe activity were correlated with signs of temporal lobe experiences, there may be more effective electroencephalographic indicators. There is clinical and experimental evidence that interitical spikes can be used as inferences for the occurrence of kindling with amygdaloid nuclei (Goddard, Dragunow, Maru, Macleod, 1986). During this process the same pattern of electrical stimulation recruits larger and larger aggregates of neurons until the discharges are propagated to motor areas. We (Makarec & Persinger, 1985) have found that numbers of spikes per minute, defined as graphic transients whose peak to peak amplitudes are a factor of 2 or greater than the baseline width, were correlated with many of the experiences that might be considered "interictal" within the TLS cluster. Traditionally, spike-like measures are virtually ignored in nonpathological populations; the usefulness of these EEG transients should be explored.

Our research indicates that the isolation and characterization of temporal lobe signs within the normal population may be helpful in understanding the display and the mechanisms of several forms of human behaviors (Persinger, 1987a), including creativity and the experience (but not necessarily the validity) of psi or paranormal experiences. People who show many and varied temporal lobe signs are very likely to experience frequent subjective psi phenomena (Persinger & Makarec, 1987). Poets and writers also display extreme scores on the TLS profile (Makarec & Persinger, 1985). The history of exceptional writers is replete with the symptoms of TLS and the correlative personality features, including hypomania. Pursual of the temporal lobe cluster in human behavior may help us understand both pathological and creative processes.

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